

**Year Two Progress Report submitted to  
NOAA's Human Dimensions of Global Change Research (HDGCR) Program**

**Title: Decision Making under Risk of Extreme Climate Events**

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**Preliminary Materials**

**A. Abstract**

Evidence from the field of seasonal climate forecasting applications has shown that it is difficult to relay new climate information to users in a format that is useful, partially because cognitive biases in perceptions of uncertain, probabilistic climate information may inhibit good decision making. This lesson has useful application in the area of promoting adaptation to climate change. Expectations for the coming season or seasons, whether based on climatology, a seasonal forecast, or knowledge of climate change, are susceptible to cognitive biases, and decisions arising from these expectations are influenced accordingly. Observational and model-based data support the assertion that climate is changing, making critical the societal goal of improving our ability to respond to new climate information. Observed changes are manifest as increases in extreme events, which influence mental models of climate and, in turn, shape climate-sensitive decisions. This proposed research draws on insights gained in the arena of seasonal forecasting, taking advantage of current responses to extreme climate events, to better understand and address the ways in which mental models of climate influence adaptation to climate change.

Given the tight linkages between farming systems and climate, we are utilizing an agricultural setting for this work in the expectation that mental models of climate among

farmers should be particularly well-developed and will lead to useful results. Our work is being conducted in the Northeast US, a region without seasonal forecast skill, which ensures that mental models of climate are based solely on experience and expectations for climate change. Using written surveys and in-person interviews with dairy and vegetable farmers, we are mapping mental models of important climate events, including expected ranges and return frequencies, and identifying the relationship between mental models and resource management decisions. Farmer perceptions will then be compared with distributions of observed climate based on historical records drawn from local stations. To address cognitive biases identified through interviews, we will develop and deliver instructional materials in workshop and focus group settings. Instructional materials will be based on a range of materials drawn from seasonal climate forecast materials developed by the PIs for use in Africa, results of psychology lab experiments, and creative visualization techniques to help decision makers envision climate and decision contingency scenarios. Additional visits with farmers following extreme events that occur during the study period will provide opportunities for evaluating instructional materials, and furthering our understanding of risk management and decision making under climate uncertainty.

#### B. Objective of Research Project

The primary objective of this work is to understand if cognitive biases of farmers in Eastern New York State impede their ability to adapt to climate change or if, in fact these biases facilitate adaptation. Given the evidence of increased variability in rainfall and temperature events in the Northeast US, coupled with the phenomenon of exaggerated emphasis on recent climate events in people's perception of what is "normal", we expect to observe some adaptive responses occurring already. Adaptation to increased frequency of extreme events is likely to fall into two primary categories – the use of insurance instruments to protect against routine losses, or increased diversification in production methods, farm products, and/or marketing arrangements. This work seeks to improve our understanding of the factors which influence farmer decision making in the context of climate risk, and based on this understanding develop educational materials to facilitate decisions related to climate change.

#### C. Approach

*Approach:* Our research team (an agronomist, Phillips, a psychologist, Krantz, and a climatologist, Lyon) has designed and delivered both written and in-person surveys to a sample of the farming community in Eastern NY, primarily from the population within approximately 100 miles of Albany. Selecting from this group, we will hold one to two workshops, presenting information on climate variability, climate change, and decision making in the context of climate risk, and evaluate decision making aids developed.

*Population:* In the Northeast US, skill in seasonal climate forecasts is too low for practical application. This lack of a seasonal forecast simplifies our study because expectations for the coming season are based solely on experience and knowledge of climatology, and possibly perceptions of the influence of climate change. If this perception was additionally influenced by a seasonal forecast, it would complicate our attempts to isolate mental models of current and future climate.

Both dairy and vegetables are important products for New York State (NASS, 1997). Our survey will focus on these two producer groups rather than one segment in order to protect against producer biases. However, fruit production is also important in the Hudson River Valley and some fruit farmers may be included.

*Data collection:* In year one, a baseline survey was mailed to approximately 250 farm families, with an expected return rate of approximately 25%. This initial survey covers demographics, general information about the farming system, length of time farming, perceptions about and responses to past extreme events and expectations for the future of their operation. This set of data will serve two purposes. First, from this larger sample, we have been able to estimate general perceptions of climate change and risk management strategies, and second, we are using the responses to identify a cohesive set of farmers willing to participate in the on-going study.

Historical records of daily weather data have been secured for a number of sites in the region. We will perform simple statistical summaries of the distribution of climate variables identified by farmer participants.

*Climate education materials:* Based on an analysis of the data collected, instructional materials are being developed for testing at each of two one-day workshops being conducted in years two and three. The objectives of the workshops are 1) to provide a forum to present new information about climate, climate change, and information resources that exist; 2) to test new visualization techniques that we will design to address cognitive biases in perception of climate and to aid in decision making with new climate information; and 3) to conduct group exercises in decision making with uncertain information, using a contingency planning approach, designed to explore multiple outcomes and implications of various trade offs.

*Additional interviews and focus groups.* In the period following the first workshop (winter/spring 2006), we will perform a second full set of interviews. Ideally, this set of interactions will be timed to follow on the occurrence of an extreme weather event. Our objective will be to test for changes that may have occurred in response to the climate experience, as well as to look for impacts of the information they received at the workshop. In addition to resampling their perceptions, we will collect information on responses in terms of the “quick fix” versus retooling the system to build resilience against the event’s possible return. Data will be analyzed and used to revise the workshop materials.

In the final year, we will hold one additional workshop, opening up the invitation to other, non-participating farmers and extension agents. This will be the final opportunity to present and evaluate our educational materials. Through the use of some simple evaluation techniques, we will gather data that allow us to compare perceptions of participating and non-participating farmers.

## II. Interactions

- A. *Decision Makers*: Our study rests on the collaboration of farmers in Eastern New York State, from whom we will benefit in increasing our understanding of decision making under climate risk, and who we hope will benefit from the process of interaction over the three-year study. The primary farmers to benefit from the work will be those who agree to work with us for the duration of the study, but we expect there to be a ripple effect as they interact with others in their community. Furthermore, Cornell Cooperative Extension agents in the counties where we are working will participate in the workshops.
- B. *Climate forecasting community*: In addition to Brad Lyon, one of the co-investigators from the IRI, others at the IRI have shown interest in discussions with us regarding the information presented to farmers on climate change and variability. Lisa Goddard, in particular, is meeting with the P.I. to discuss the implications of both climate change model output for the northeast and analysis of trends in historical data. Additionally, we expect to share our results at workshops and climate research meetings.
- C. *Other research efforts*: This project is tightly coordinated with the work underway by the NSF-funded Center for Research in Environmental Decisions (CRED) at Columbia University. The team has been granted funds for additional work beginning in 2007 through CRED and is participating in annual workshops, exchanges of materials and instruments, and discussions with the other researchers funded through CRED. Dave Krantz is one of the PIs at CRED and forms the tightest linkage with that group. Outcomes from the lab work associated with the Center will be utilized in developing the educational materials to be tested with farmers and survey instruments focused on perceptions of climate change are shared among researchers at the Center.

## III. Accomplishments

*Tasks Accomplished to date Yr 2: Interviews.* Our objectives for the interviews have been refined and include a) gathering additional data regarding the mental model of frequencies of extreme events, b) investigating farmer decision making processes including their primary sources of information and major influences on decisions, and c) to present a simple scenario of increased frequency of extreme events (orally) and solicit their likely management response to the scenario in order to identifying their usage of the “insurance approach” versus the “diversification” approach to risk mitigation. Scheduling interviews over the summer proved to be difficult with farmers’ heavy workloads. Twelve interviews were conducted on farms over the summer of 2005. Interviews were distributed among dairy, vegetable and fruit growers.

Workshop. On January 20<sup>th</sup> 2006 a one-day workshop was held in a small town in the Catskill Mountains. There were 12 farmers in attendance and several farm consultants representing Cornell Cooperative Extension and the NYC Watershed Agricultural Council. The workshop was organized into three main parts: a)

Introductions, overview of project and survey results (Jennifer Phillips) 2) Presentation of local climate data analysis and impacts of climate change on probabilities of extreme events (Brad Lyon), and c) Discussion on risk management lead by Dave Krantz. Lunch made with locally produced food was served in a hotel next door to the conference center.

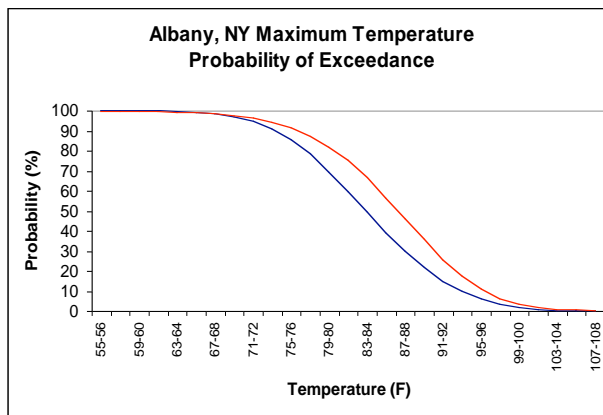
Additional Mailed Surveys. In order to increase the size of the sample of farmers in the Hudson Valley in the mailed survey, we sought and received cooperation from the Cornell Cooperative Extension office in Washington County where the population of working farms is relatively high. In early March 2006, we mailed an additional 250 surveys and received a 17% response rate. This new set will provide some additional perspective since the summer preceding each winter survey had very different weather conditions. The total number of surveys received back is thus 119. Data is being entered into SPSS.

Interviews 2006. Farmers who responded to the spring 2006 mailing and agreed to be interviewed are being contacted to set up meetings. The goal is to collect an additional twelve to fifteen interviews in the summer of 2006. Additionally, farmers participating in year one surveys and interviews will be contacted for short telephone interviews.

Conferences attended. A poster was presented at the U.S.Climate Change Science Program Workshop in the fall of 2005: "Farmer Climate Risk Management: Insights into Climate Change Adaptation Capacity" by Phillips, Krantz and Lyon.

*Preliminary Findings 2005/2006:* Given that the weather was so different in 2004 compared to 2005, and that the farmers returning the survey had those two years to reflect upon, we have the opportunity to look for the "recency effect". We are now in the process of entering responses to the second set of surveys and will see if last summer's drought influences their perception of the frequency of droughts in the Hudson Valley. Preliminary analysis indicates that the 2006 survey respondents perceive high wind and hail as much more of a problem than the 2005 respondents, a majority of whom cited excess rain as the most problematic. We are in the process of analyzing climate data from Washington County to see if there were differences from the counties surveyed in the previous year.

Part of the workshop was devoted to presenting climate data series in a number of formats in order to get feedback on comprehension. We found that probability of exceedence curves for extreme events (e.g. single-day rainfall or maximum temperatures) for specific sites familiar to the participants had very strong responses. The curve below illustrates the increase in likelihood of exceeding 85 degrees F in July in Albany NY under a specified increase in average temperature. Farmers suggested that we generate a set of this sort of graph for a number of variables using data from the nearest weather stations for them to reference.



Additional knowledge gained through interviews and at the workshop was that, although farmers are worried about climate, the larger concern of economic survival of their farms overshadows their decisions. Diversification is aimed not only at reducing climate risk but also for the purpose of exploring new markets. Whatever adaptation strategies are encouraged, they will necessarily have to be ones that do not put additional strain on finances.

Adaptive responses to climate extremes go further than the two categories initially hypothesized: insurance or financial strategies and diversification. A third major category utilized by many farmers is technological in nature. For example, many farmers reported buying larger tractors so they could remove excessive snowfall, or buying generators so they could cope with power outages common in high snow, ice, or wind events. Very few farmers report making major changes in their farm management such as switching to new products that are less susceptible to weather extremes. A majority do not perceive trends in the weather, so it is not surprising that responses to extreme events tend to be simple mechanisms to keep doing things they way they have done them before.

#### IV. Relevance to the field of human-environment interactions

- A. *Relationship of our results to the field of decision making under climate risk:* Work by Weber (1997) with farmers in the Midwest has confirmed the idea that events recently experienced tend to be weighted more strongly in mental models of climate. We will extend this work by investigating the decision sets that are based on this “near term event” bias. Furthermore, the impact of time horizon on planning and risk management will be central to the work. Responses to extreme events occurring in the present but perceived as part of the longer term climatology may exhibit “preventionist” behavior, or “promotionist” (opportunistic) qualities as proposed by Higgins (1997), in his work on regulatory focus. Either approach may be adaptive in the face of climate change, however, clarifying response types may help in the

development of support structures for the agricultural community. Strategies for intervention to encourage adaptive behavior in anticipation of increased climate risk will be formulated in light of work by Weber (2004) regarding varying responses to risk based on experience versus descriptions.

- B. *Relationship to previously funded HDGEC research:* This work builds on previous work by the PI (Phillips) working with farmers in East and southern Africa regarding the use of seasonal climate forecasts. In that previous work the focus was on improving the communication of seasonal forecasts to farmers to promote better climate risk management strategies. Among the many lessons learned in the African context, a central one is that farmers, being more climate sensitive than many other managers, are adept at managing climate risk but have limited access to new information that is relevant to their production systems. The current work will add our knowledge of how to present information about future climate risk for farmers here in the Eastern US. Although the timescales for forecasts differ (seasonal versus longer term), actions in the present are based on interpolations from longer term climatology and some sense of interannual variability and our communication efforts will necessarily draw on similar foundations.
- C. *Contribution to other areas of study:* This work specifically addresses the question of societal ability to adapt to climate change, and indirectly the mitigation of natural hazards. Understanding how people update their mental models of climatology, particularly regarding extreme climate events, will shed light on the potential for adopting adaptive strategies. Depending on the sensitivity of the activity, extreme climate events are often categorized as natural hazards, and decreasing our vulnerability to extreme events will help the transition in a changing climate. Although in the case of longer term climate change, climate information differs from seasonal forecasts, as is argued above, handling the variability around the trend is the difficult part and thus this work relates strongly to the work on-going in the seasonal forecast applications realm. We intend to develop approaches to aid in decision making in the face of increased variability in extreme climate events, and these approaches will rely heavily on communicating uncertainty.

## References

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